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NASA TECH BRIEF

The Effects of Nuclear Power Generators Upon Electronic Instrumentation

A major concern with the use of a radioisotope thermoelectric generator (RTG) power system is whether the radiation emitted by the heat source will interfere with the electronic instrumentation. This problem is presently being studied in depth and a preliminary evaluation is presented here which indicates the general approach being taken and some tentative conclusions. Information derived from this program can readily be used in calculating shielding requirements for commercial nuclear reactors. Also, the program has presented new approaches which would aid in the design of instrumentation operating in a radiation environment, such as a medical neutron-therapy room.

The gamma field and the neutron field in the vicinity of an RTG originate primarily from the radioactivity of the Pu-238 and associated radioactive nuclides in the heat source. The gamma field is due mainly to the gammas emitted by the plutonium isotopes and their daughter products in the heat source. A small additional contribution to the gamma field is caused by gammas created by the interaction of emitted neutrons with surrounding materials. The neutron field is mainly due to the (α, N) reactions with impurity elements associated with the plutonium oxide in the heat source.

A number of electronic instruments, considered to be the most susceptible to neutron and gamma radiation, were selected for evaluation and classified according to their radiation sensitivity. Since the sensitivity of the electronic instruments to RTG radiation varies with the energy of the radiation, an accurate spectral distribution of the emitted energy was necessary. A 20-group structure between the energies of 40 keV and 10 MeV was used in the analysis. Suitable analytical models were developed to predict the effects of the radiation spectrum upon the instruments. Both the RTG neutron and gamma spectrum were considered, although it was recognized that the main effects were due to gamma radiation; the neutron interference was of a secondary nature requiring first the production of gammas through the interaction with surrounding structure and shield material.

The principal finding was that the gamma field of the RTG would affect the operation of the electronic instruments and would therefore require shielding, while the neutron field would not interfere with their operation either directly, or indirectly, via secondary capture-gamma production.

Recommendations which follow from the analysis are: (1) considerable effort is justified on physical orientation, spacing and placement of the RTG to take advantage of the potential self-shielding of one part of the RTG by other parts of the RTG itself; (2) shielding by any surrounding structural members should be exploited; (3) depleted uranium should be used for shielding instead of tungsten; and (4) the use of higher grade fuel, approaching biomedical grade in freedom from Pu-236 should be examined, as a means to lower the eventual gamma fields to be expected in the vicinity of the RTG.

The analysis and conclusions are being refined by further analytical studies. Monte Carlo codes in a computer analysis are being used to find the response of the instruments as a function of the radiation spectrum presented to them.

Note:

Requests for further information may be directed to:

Technology Utilization Office
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: B70-10272

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA Code GP, Washington, D.C. 20546.

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